

CLAIMS

1. A rolling device comprising an outer member and an inner member each having a raceway surface and rolling elements rolling on the raceway surface by rotational or linear movement of the outer member or the inner member in which

the outer member and/or the inner member is constituted with at least one kind of titanium alloys of β type titanium alloys, near type titanium alloys and $\alpha + \beta$ type titanium alloys.

2. A rolling device as defined in claim 1, wherein the titanium alloy has a surface hardness of Hv 400 or more and less than Hv 600.

3. A rolling device as defined in claim 2, wherein the outer member and/or the inner member has a core hardness of Hv 420 or more and have an oxygen compound layer at the surface, and the oxygen compound layer comprises titanium oxide containing rutile type TiO_2 and has a thickness of 20 nm or more.

4. A rolling device as defined in claim 3, wherein the core hardness of the outer member and/or the inner member is

Hv 450 or more and a thickness of the oxygen compound layer is 50 nm or more.

5. A rolling device as defined in claim 1, wherein the rolling element is constituted with at least one kind of materials of titanium alloys, silicon nitride, silicon carbide, zirconia series ceramics, alumina series ceramics and SIALON series ceramics.

6. A rolling device comprising an outer member and an inner member each having a raceway surface, rolling elements rolling on the raceway surface by rotational or linear movement of the outer member or the inner member and a cage for holding the rolling elements in which

the outer member and/or the inner member is constituted with one kind of titanium alloys of β type titanium alloys, near type titanium alloys and $\alpha + \beta$ type titanium alloy and the titanium alloy has a surface hardness of Hv 400 or more and less than Hv 600 and the cage has a heat conductivity of 20 W/(m·K) or more.

7. A rolling device as defined in claim 6, wherein the cage is constituted with one kind of materials of copper, tellurium copper, brass, aluminum bronze, phosphorus bronze, nickel silver, cupro nickel and beryllium copper.

8. A rolling device comprising an outer member and an inner member each having a raceway surface and rolling elements rolling on the raceway surface by rotational or linear movement of the outer member or the inner member in which

at least one of the outer member, the inner member and the rolling elements is constituted with a titanium alloy and which has a ω phase with the size of the crystal particles of 1 μm or less.

9. A rolling device as defined in claim 8, wherein the size of the crystal particles is 800 nm or less.

10. A rolling device as defined in claim 8, wherein the size of the crystal particles is 10 nm or less.

11. A rolling device as defined in claim 1, wherein the outer member and/or the inner member has a hard film on the raceway surface.

12. A rolling device as defined in claim 11, wherein the raceway surface formed with the hard film has a surface hardness of Hv of 350 or more.

13. A rolling device as defined in claim 11, wherein the raceway surface formed with the hard film has a surface hardness of Hv of 450 or more.

14. A rolling device as defined in claim 11, wherein the hard film is constituted with at least one kind of materials of TiN, TiC, TiCN, TiAlN, CrN, SiC and diamond-like carbon.

15. A rolling device as defined in claim 11, wherein the outer member and/or the inner member has a lubricating film of 0.1 μm to 10 μm on the hard film.

16. A rolling device as defined in claim 11, wherein the outer member and/or inner member has a lubricating film of 0.1 μm to 5 μm on the hard film.

17. A rolling device as defined in claim 1, wherein the rolling element is constituted with a superhard alloy or cermet.

18. A rolling device as defined in claim 17, wherein the rolling element has a heat conductivity of 35 W/(m·K) or more.

19. A rolling device as defined in claim 17, wherein the rolling element has a heat conductivity of 50 W/(m·K) or more.

20. A rolling device as defined in claim 1, wherein the rolling element has a surface hardening layer constituted with an iron and steel material and has a corrosion resistance on the surface.

21. A rolling device as defined in claim 20, wherein the surface hardening layer is formed by applying a chromium diffusion penetration treatment on the surface of a base material constituting the rolling element.

22. A rolling device as defined in claim 20, wherein the surface hardening layer contains a nitride layer formed by applying a nitridation treatment to the surface of a base material constituting the rolling element.

23. A rolling device as defined in claim 1, wherein the titanium alloy is the titanium alloy satisfying the condition: $3.7 \leq (H/E)$ where E (Gpa) represents the Young's modulus and H (Hv) represents the minimum hardness for the portion from the raceway surface to a depth corresponding to 2/100 to 5/100 for the diameter of the rolling element.

24. A rolling device as defined in claim 1, wherein the titanium alloy is a titanium alloy satisfying the condition:

4.0 \leq (H/E) where E (Gpa) represents the Young's modulus and H (Hv) represents the minimum hardness for the portion from the raceway surface to a depth corresponding to 2/100 to 5/100 for the diameter of the rolling element.

25. A rolling device as defined in claim 23 or 24 wherein (H/E) is 4.5 or less.

26. A rolling device as defined in claim 1, wherein the ratio α_2/α_1 between the heat expansion coefficient α_1 of the titanium alloy and the heat expansion coefficient α_2 of the rolling element is within a range of 0.4 to 1.3.

27. A rolling device as defined in claim 1, wherein the rolling device further comprises a shield plate for shielding an opening formed between the outer member and the inner member and the shield plate is formed of titanium at a purity of 99.5% or higher.

28. A rolling device as defined in claim 26, wherein the outer member and the inner member each has an oxide film containing TiO_x ($x = 0 - 2$) on the surface.

29. A rolling device as defined in any one of claims 8, 11, 16, 19, 22, 25 and 26 wherein the rolling element is

constituted with at least one kind of materials of titanium alloys, silicon nitride, silicon carbide, zirconia series ceramics, alumina series ceramics and SiALON series ceramics.

30. A rolling device as defined in any one claims 2, 11, 16, 19, 22, 25 and 26 wherein the rolling device further comprises a cage for holding the rolling elements and the cage is constituted with one kind of materials of copper, tellurium copper, brass, aluminum bronze, phosphorus bronze, nickel silver, cupro nickel and beryllium copper.

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